Spatial Conservation Assessment for Balancing Avoidance of Impacts of Tilapia Introduction on Imperiled Fishes with Economic Impacts to Stakeholders

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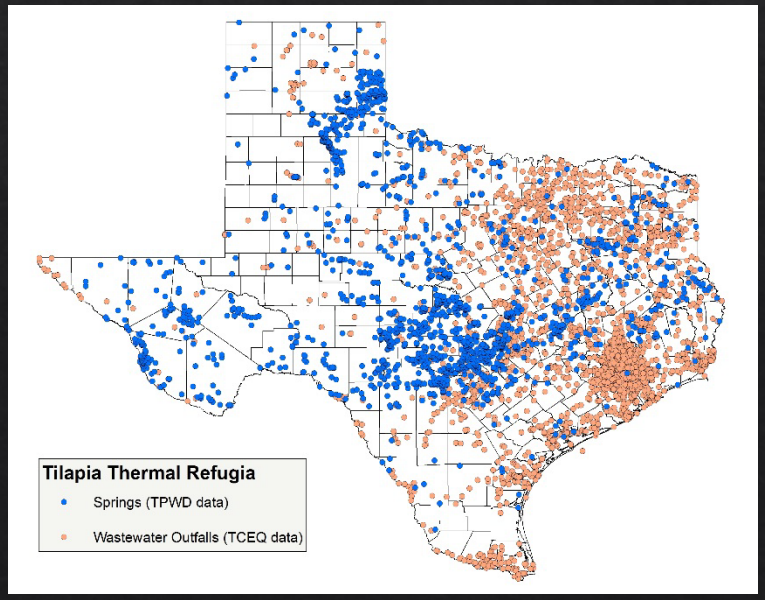
Tilapia Regulation in Texas

- “Tilapia have been restricted in.. Texas because they can over-winter in warm climates or in heated, power plant reservoirs or thermally-stable springs."
- “…historically it was believed that limited cold tolerance would limit their distribution in Texas ; therefore, blue and Mozambique tilapia were exempted from the original tilapia restrictions.”
- - Howells, 1999



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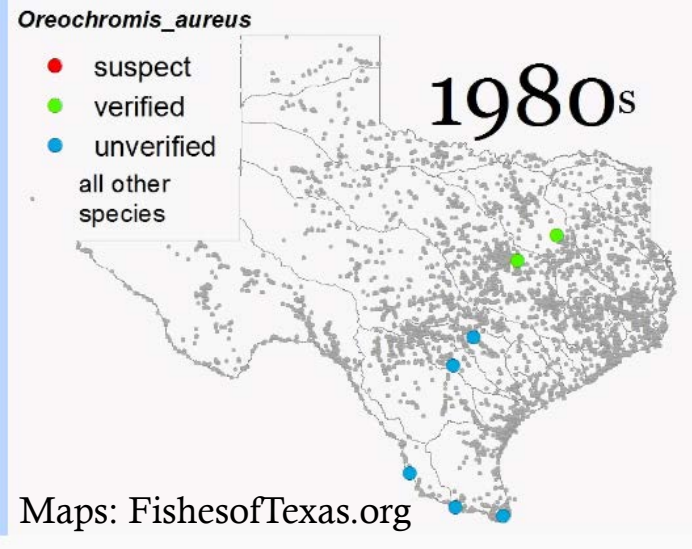
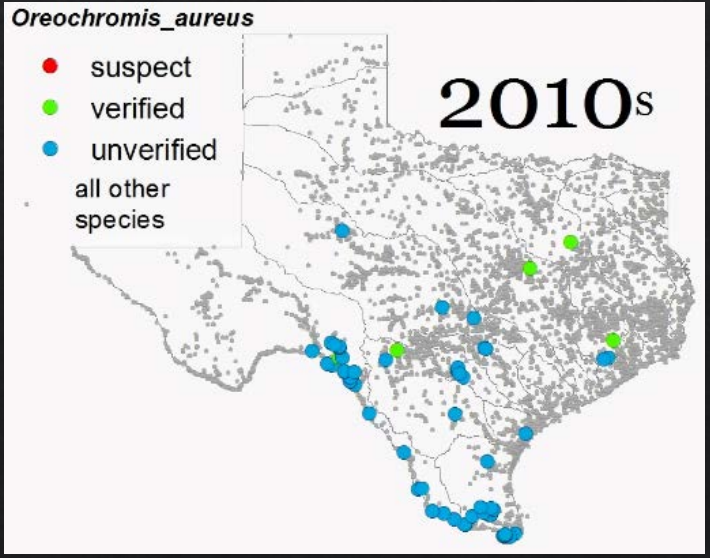
Tilapia in Texas Waters

- 1956 - Mozambique Tilapia *(Oreochromis mossambicus)* escape into San Antonio River
- 1960s - Blue Tilapia (*O. aureus*) "appear" in reservoirs
- 1978 - Redbelly Tilapia *(Tilapia zillii)* escape from zoo into SAR
- Blue most widespread, some Blue/Moz hybrids*, and a few Nile…





Maps: FishesofTexas.org

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Tilapia in Texas Waters

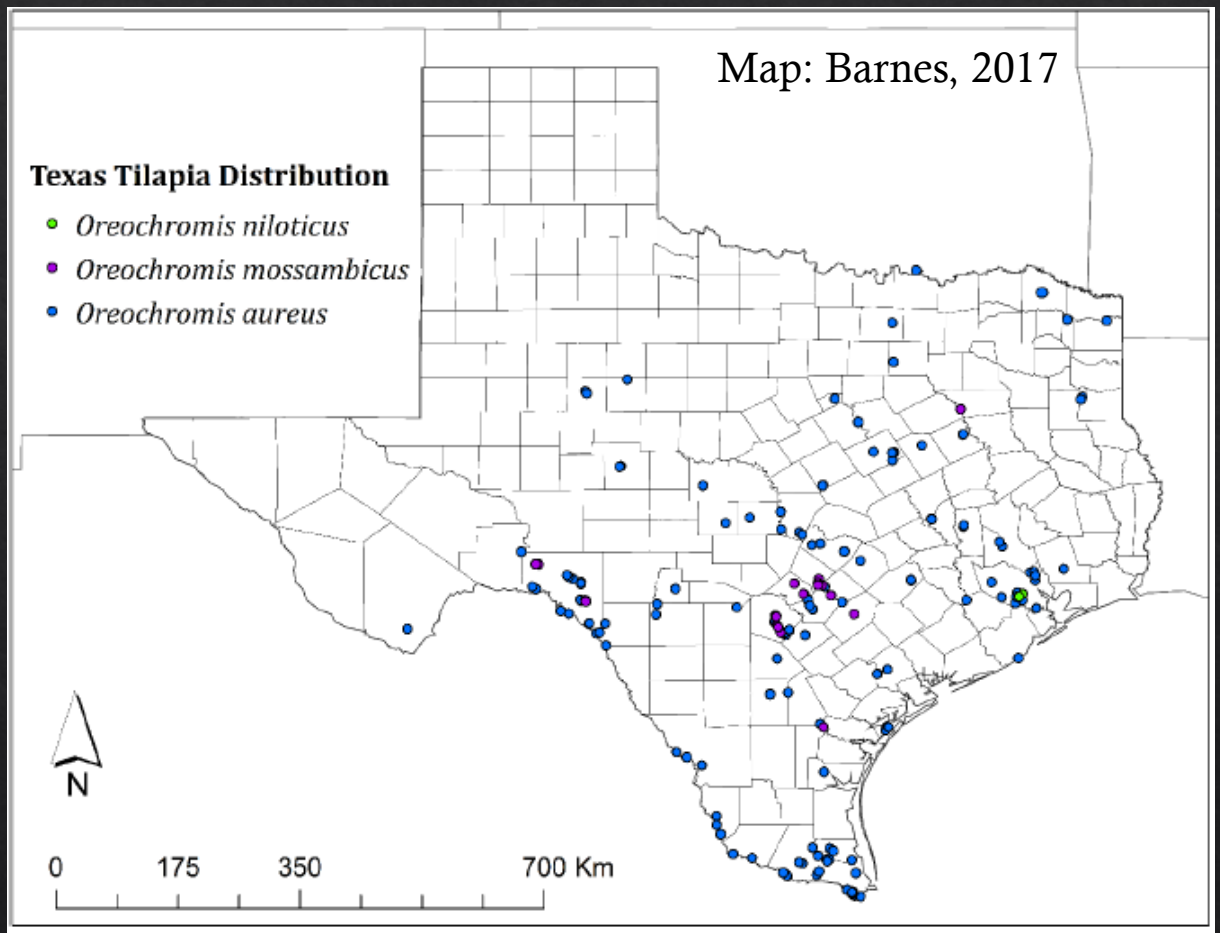

Figure 2. Tilapia species occurrence in Texas. Data was obtained from Global Biodiversity Information Facility (GBIF), Biodiversity Information Serving Our Nation (BISON), Fishes of Texas Database (FoTx), Multistate Aquatic Resource Information System (MARIS) and GoFish by Texas Parks and Wildlife Department.

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Tilapia Regulation in Texas

- 1988 – Rule revisions restricted aquaculture to Blue (*Oreochromis aureus*) and Mozambique (*O. mossambicus*) Tilapia
- Current regulations prohibit tilapia of 3 genera – *Oreochromis, Sarotherodon, Tilapia*
- Regulatory exception allows possession of Mozambique without permit (i.e., oversight) – commonly stocked in private ponds
- "**Unfortunately, although both blue and blue tilapia hybrids have become established more widely than originally believed possible, too many aquaculturists were rearing these species to practically allow a total ban.** Subsequently, these two species and their mutual hybrid were allowed to remain as cultured fishes but with permits and stock identifications required. Nile tilapia was added at a later date. … Mozambique tilapia may be stocked in private waters as forage."
  – Howells, 1999

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Tilapia Regulation Review

- **Issue #1: Inability to identify to species inhibits enforcement**
  - No consistent morphometric or meristic distinguishing traits
  - No "pure" genetic stocks for comparison
  - Unfortunately, many tilapia species have become badly hybridized, especially among aquacultural specimens, including some native stocks in Africa. Identification of most species is difficult or impossible without resorting to electrophoretic analysis to confirm genetic identity." – Howells, 1999 (also 1991)
- **Proposed Solution: Regulate all 3 (or 4?) tilapia species the same**

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Tilapia Regulation Review

- **Issue #2: Private pond stocking and escapement**
  - Mozambique Tilapia sales for pond stocking seem to be on the rise
  - Concerns from various partners regarding invasive tilapia
  - No oversight of pond stocking and potential for escapement
- Escape of fish from private ponds into public waters without a 'stocking permit' is a violation of Texas Statute [PWC 66.015].
- TPWD Stocking Policy requires:
  - **consideration of impacts** of public water stockings on the existing biological ecosystem [31 TAC §52.104]
  - private pond stockings of exotic fish must have **no adverse impacts** on state or federally listed threatened or endangered species or their critical habitat [31 TAC §52.401].
- **TPWD Response: Conduct review of regulations in other states, transport invoices, literature on tilapia, and potential impacts to imperiled fishes, identify potential solutions**

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Exotic Species Transport Invoice Review

- **2016 Buyer Numbers** – 1,531 unique 2016 Mozambique tilapia buyers (other than markets, restaurants, fish dealers)
- **2016 New Buyer Numbers** – ~81% (i.e., 1,240) were new buyers (no ESTI from 2015)
- **Review outcome - Private ponds permit not feasible**
  - Too many ponds
  - Would have to be fee-free (HB1290)

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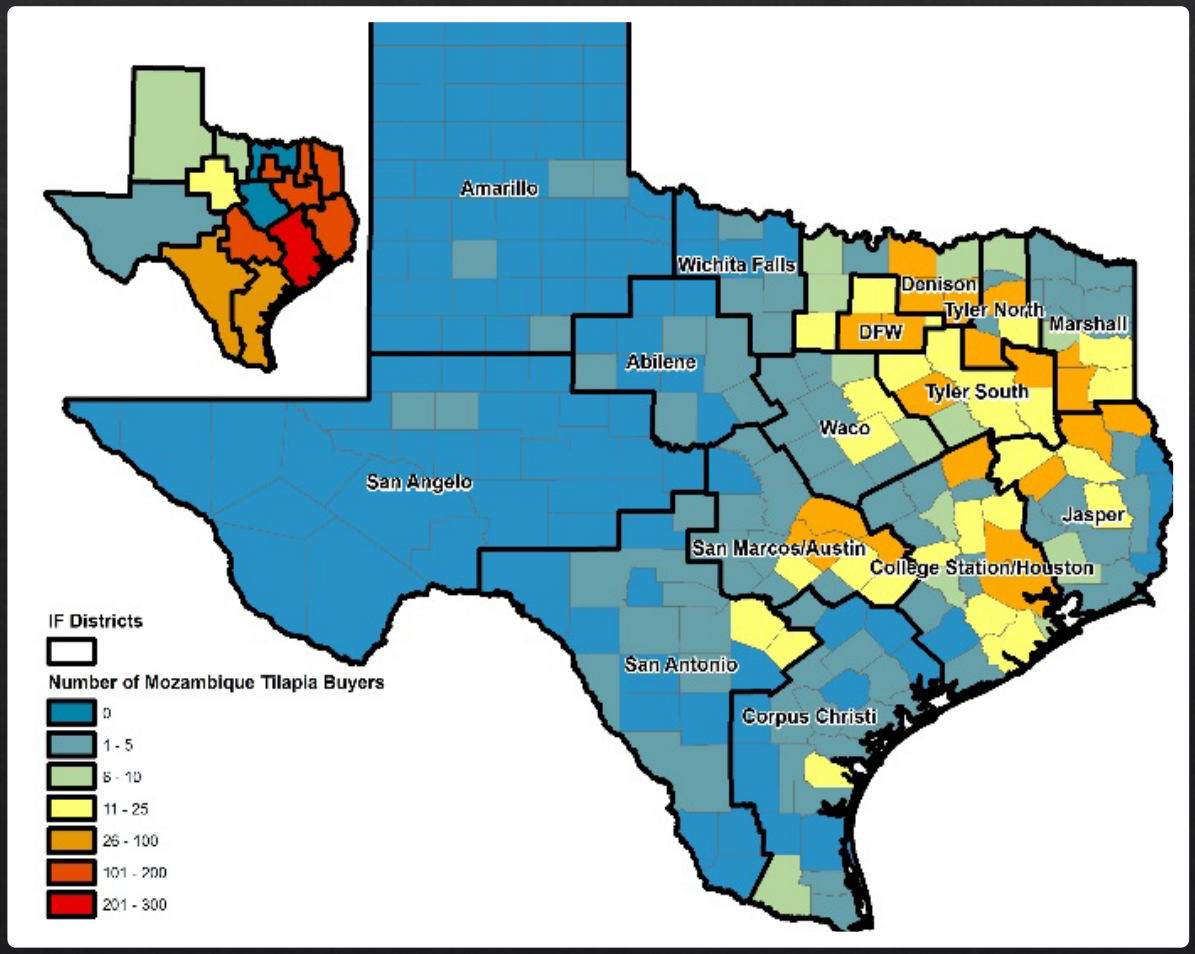
Exotic Species Transport Invoice Review

- 96% of 2016 buyers (i.e., 1,475) had viable location information



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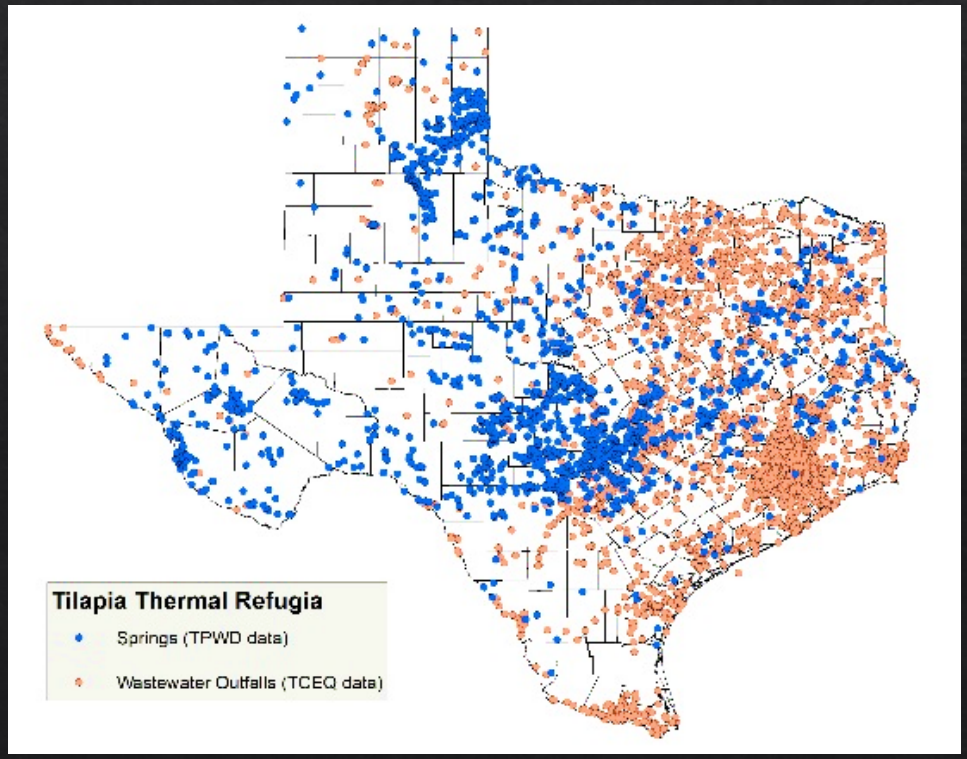
Tilapia Literature Review

- Review knowledge gaps & identify *areas* where SGCN impacts likely
- Temperature tolerance – lower limit ~8-10C (46-50F), but role of thermal refuges is a key knowledge gap for TX



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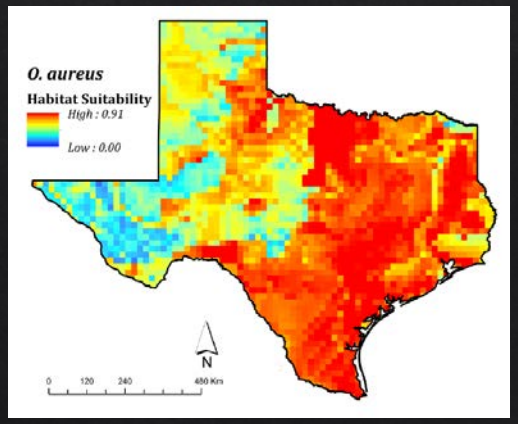
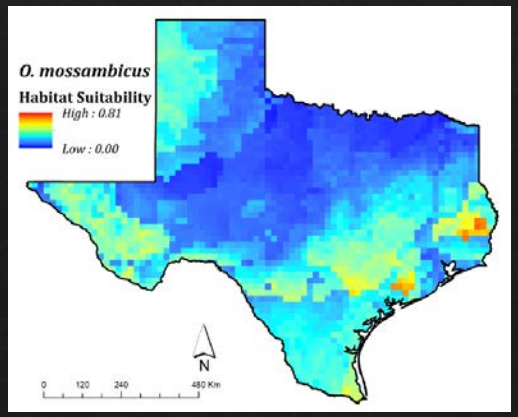
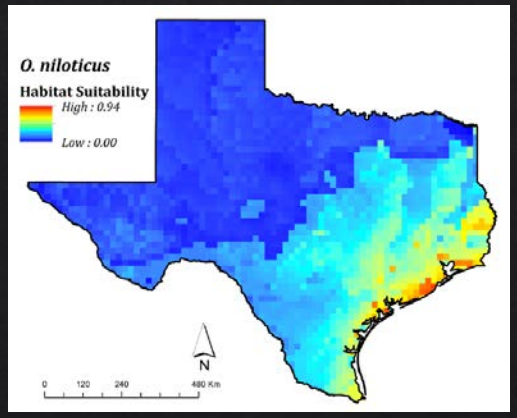
Tilapia Literature Review

- Impacts on native fishes
  - Competition (nest site & food), predation, habitat impacts
  - *Oreochromis* implicated in declines of Clupiids, Cichlids, Cypriids, Centrarchids, Cyprinodontids, Fundulids, Gobiids, etc.
  - 7 studies reported TX natives being impacted
  - 28* fish Species of Greatest Conservation Need potentially impacted
- Tilapia habitat suitability models—but where are impacts expected?







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Spatial Conservation Assessment

- Zonation spatial assessment software selected
  - Flexible and modifiable
  - Comparison of prioritization at landscape-scale vs. **regulatory unit**
  - Facilitates inverse prioritization of **lost opportunity costs for stakeholders**

- Conservation Prioritization Concept - Core Area Zonation
  - Minimizes biological loss and considers important species occurring in biodiversity-poor areas (i.e., rarity focus)
  - Used when biodiversity data layers represent species
  - Mechanism for comparing different solutions
  - **Facilitates investigation of tradeoffs between conservation and economic losses** in the most informative and flexible way

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Spatial Conservation Assessment

- Biodiversity features
  - Fish SGCN potentially impacted by tilapia (weighted for SGCN focus)
    - FoT SDMs or occurrence data by HUC8
  - Tilapia occurrence (FoT *Oreochromis* data; high negative weight; -4)

State Status Code	Definition	SGCN Focus Weight
SX	Presumed Extirpated	0
SH	Possibly Extirpated	0
S1	Critically Imperiled	2
S2	Imperiled	3
S3	Vulnerable	4
SNR	Unranked	1

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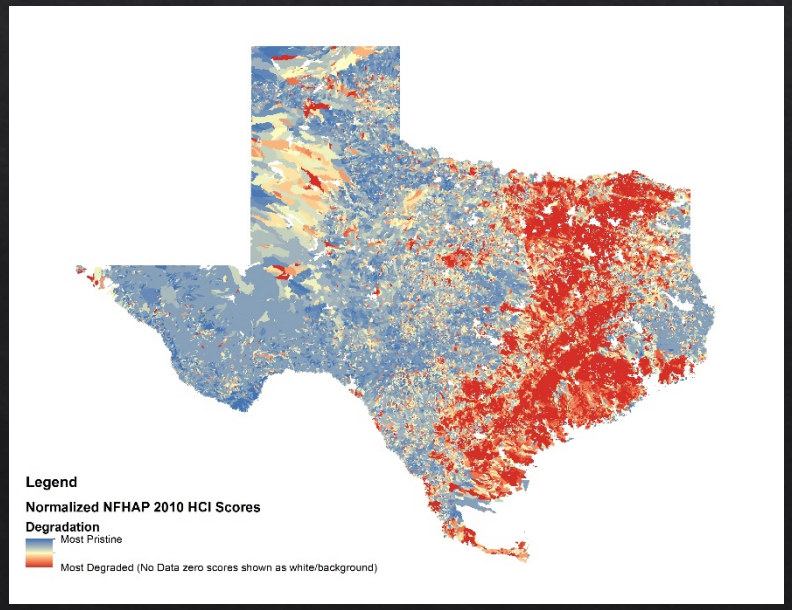
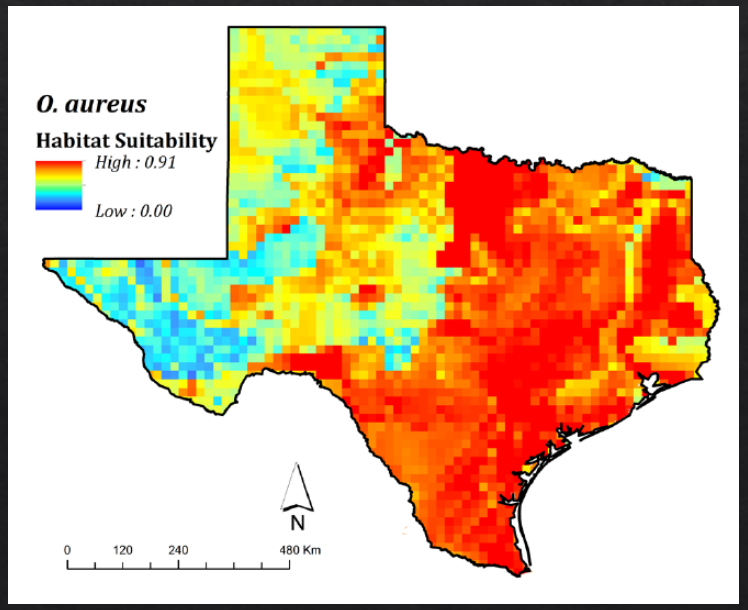
Spatial Conservation Assessment

- Habitat condition
  - Fish habitat disturbance condition (NFHAP 2010; normalized 0 – 1)
  - Tilapia invasion/persistence potential (Barnes Maxent model – *O. aureus*)
    - areas with high suitability (i.e., risk) for establishment or persistence of tilapia retained in the prioritization for conservation action as long as possible





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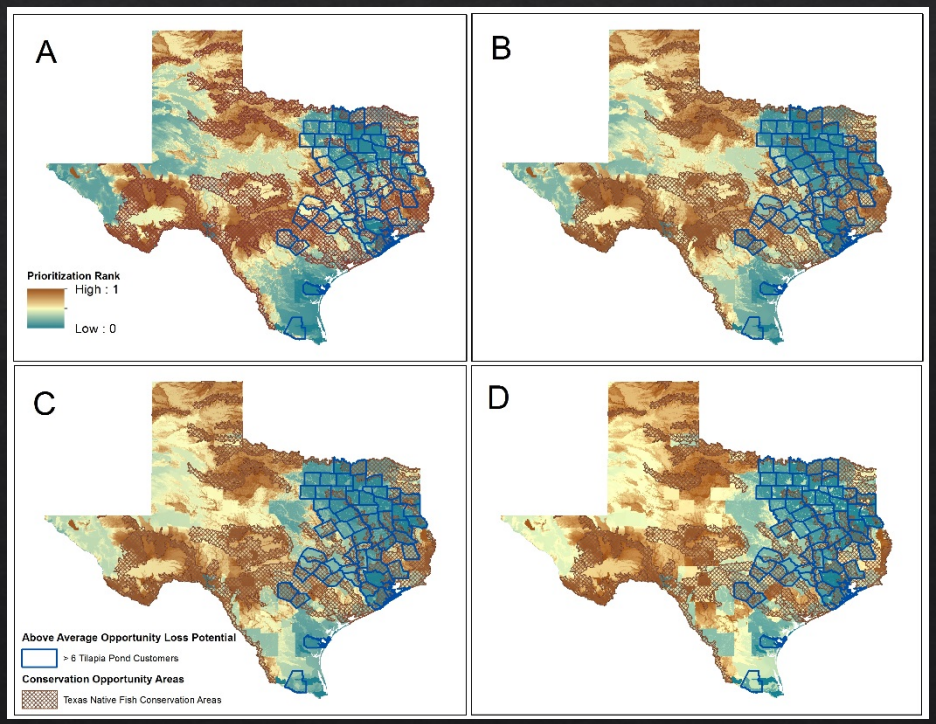
Costs to Stakeholders

- Number of 2016 buyers per county; normalized on a 0 - 1 scale (ranked to give high value to high opportunity cost)
- Negatively weighted (-3) - high conservation priority given to areas with high conservation value but low opportunity costs



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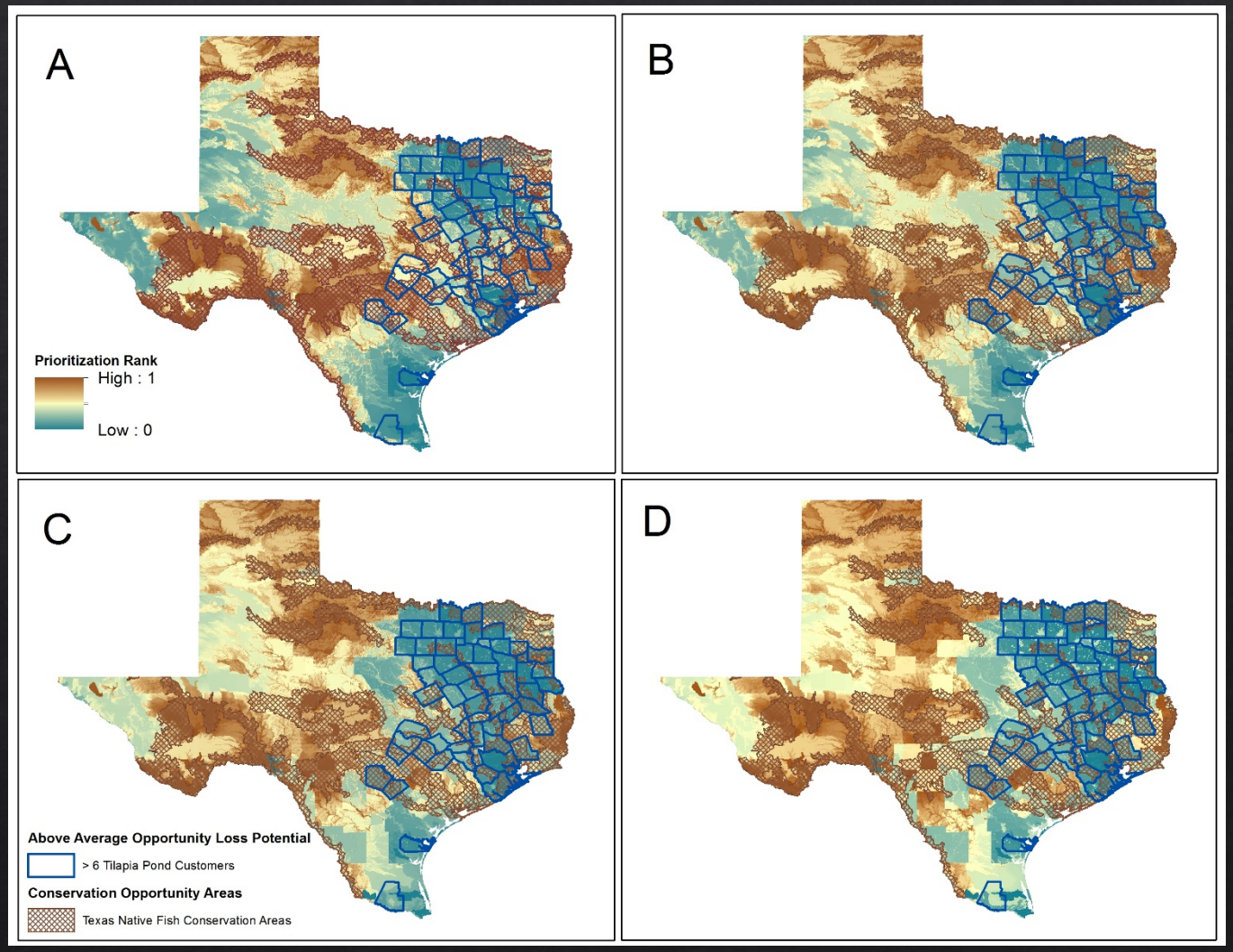

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County Planning Units

- Facilitate interpretation with respect to potential regulatory approaches
- Biodiversity value and opportunity cost are aggregated

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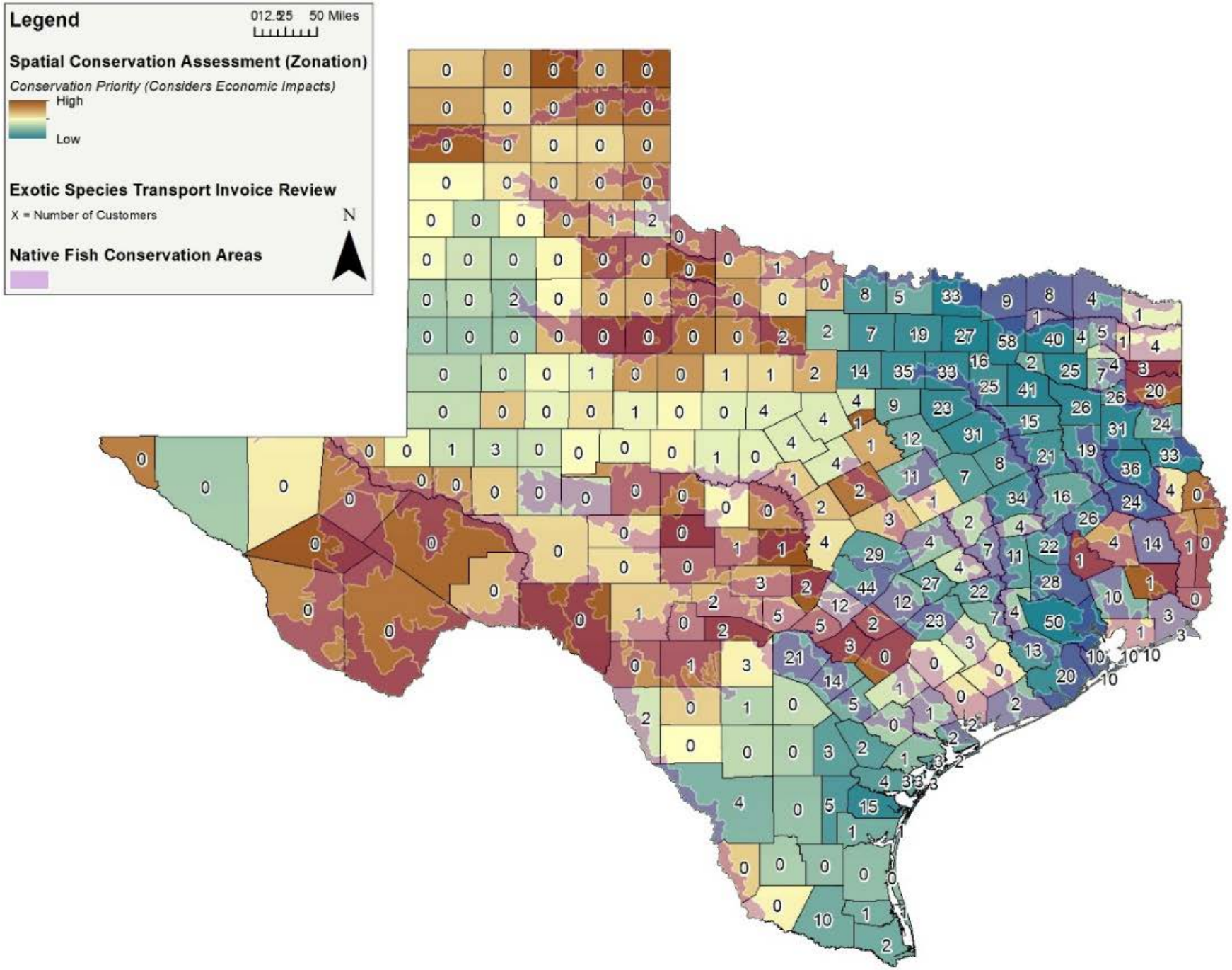
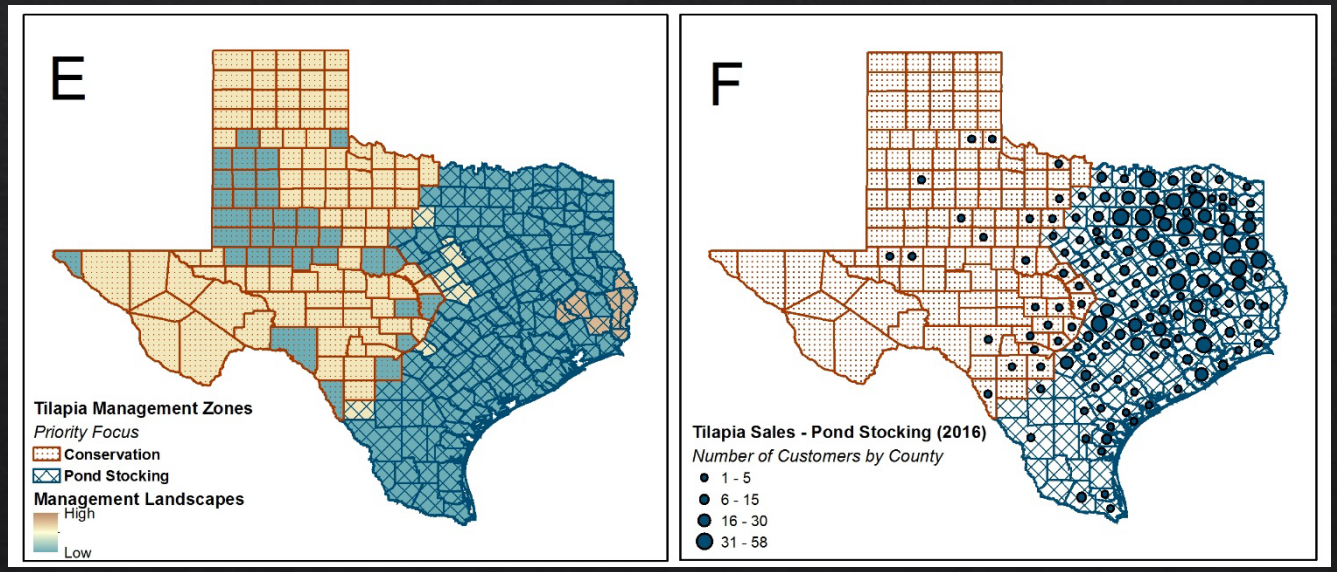

Legend
0 12.5 25 50 Miles
Spatial Conservation Assessment (Zonation)
Conservation Priority (Considers Economic Impacts)
High
Low
Exotic Species Transport Invoice Review
X = Number of Customers
N
Native Fish Conservation Areas

Landscape Identification

- Objective evaluation of priority areas for conservation
  - Landscape identification post-processing
  - Each conservation priority zone has to include at least one county among the top 10% of conservation priority valued counties across the state
- Final output requires interpretation, review, revision, review, revision, review……..



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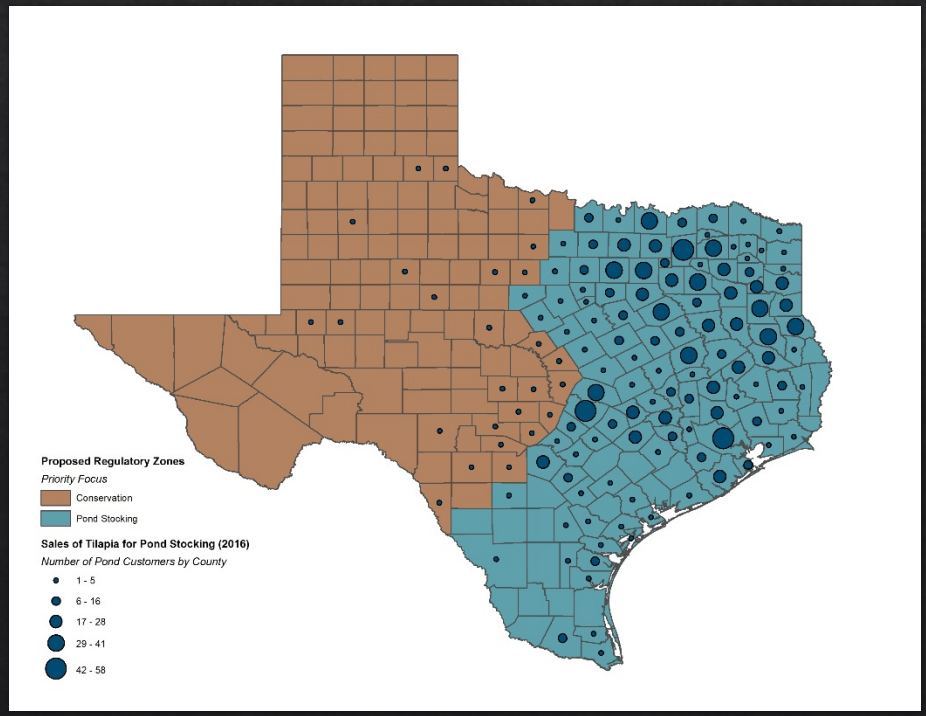
Draft Recommendations

- Private pond stocking of tilapia
  - Proposed Conservation Zone – Pond "approval"

    (review potential escapement or adverse impacts)
  - Proposed Economic Zone – Allow without restriction



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Summary

- Science-based regulatory approach that balances conservation value and economic interests
- Conservation - provide added protections for imperiled fishes and their habitats in the southern Great Plains, Edwards Plateau, and Chihuahuan Desert ecoregions
- Economic – minimize impacts of conservation actions on stakeholders, reduce regulatory burden
- Begin to bridge gaps between identification of conservation priority areas and translation to implementation of conservation actions
- Support success current and future conservation initiatives

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Thanks!

Questions?

Gratuitous Guadalupe Bass fingerling photo – Llano River conservation stocking